C-2.9 Use the equation $E = mc^2$ to determine the amount of energy released during nuclear reactions.

This concept was not addressed in physical science

Revised Taxonomy Level 3.2 C_A Apply (use) procedural knowledge

Students did not cover this concept in physical science

It is essential for students to

- Calculate nuclear binding energies
  - Calculate the change in potential energy that would occur if the nucleus were formed from its constituent protons and neutrons (for example $^{16}_{8}O$)
  - $8\,^{1}_{0}n + 8\,^{1}_{1}H \rightarrow {}^{16}_{8}O$
  - Obtain the energy change by comparing the sum of the mass of eight protons and eight neutrons with that of the oxygen nucleus
    - The mass of the oxygen nucleus, protons and neutrons will need to be supplied to 5 decimal places
    - 8 (1.67493 x 10^{-24}g) + 8 (1.67262 x 10^{-24}g) = 2.67804 x 10^{-23}g

      8 (mass of $^{1}_{0}n$) + 8(mass of $^{1}_{1}H$) = total mass of protons & neutrons
    - Mass of $^{16}_{8}O$ nucleus = 2.65535 x $^{10-23}$g
    - 2.65535 x 10^{-23}g - 2.67804 x 10^{-23}g = -2.269 x 10^{-25}g
      - The negative sign means the process is exothermic
    - The difference in energy is called the mass defect
- The mass defect is the amount of mass which is converted to energy in a nuclear reaction using the equation: $E = mc^2$, where
  - E = energy (in joules per atom)
  - m = mass defect (in kg)
  - c = the speed of light (3.00 x 10^8m/s)

Assessment

The revised taxonomy verb for this indicator is implement (use), the major focus of assessment will be for students to show that they can "apply a procedure to an unfamiliar task". The knowledge dimension of the indicator, procedural knowledge means "knowledge of subject-specific techniques and methods" In this case the procedure for producing an electric field drawing. A key part of the assessment will be for students to show that they can apply the knowledge to a new situation, not just repeat problems which are familiar. This requires that students have a conceptual understanding of electric charge and electric fields.